

CLAIMS

- 1) A method of controlling an excimer laser unit (1) to perform cornea ablation to reduce presbyopia, characterized by the comprising the step of:
 - 5 a) controlling said excimer laser unit (1) to produce on the cornea a photoablative pattern inducing a fourth-order ocular aberration.
 - 2) A control method as claimed in Claim 1, characterized in that said induced fourth-order aberration is a spherical aberration.
 - 10 3) A control method as claimed in Claim 2, characterized in that said induced spherical aberration is a positive spherical aberration.
 - 4) A control method as claimed in any one of the foregoing Claims, characterized in that said step a) comprises the steps of:
 - 15 a1) acquiring an aberrometric map of the eye indicating the visual defects of the eye, said visual defects comprising second-order visual defects including hypermetropia, astigmatism and myopia, and higher-order visual defects including spherical aberration;
 - a2) if the detected spherical aberration is negative, increasing it numerically in absolute value to obtain an overcorrect photoablative pattern inducing positive spherical aberration;
 - 20 a3) if the detected spherical aberration is positive, changing its sign and increasing it numerically in absolute value to obtain an overcorrect photoablative pattern inducing positive spherical aberration; and
 - a4) supplying the photoablative pattern so generated to said excimer laser unit (1) for implementation on said cornea.
 - 25 5) A control method as claimed in any one of the foregoing Claims, characterized in that said step a) also comprises the step of:
 - b) controlling said excimer laser unit (1) to perform specific photoablative treatment related to the visual defect of the eye associated with the presbyopia.

6) A control method as claimed in Claim 5, characterized in that said step b) comprises the steps of:

c) if the visual defect of the eye is hypermetropia, controlling said excimer laser unit (1) to perform the following operations:

5 c1) ablation of a circular corona of maximum 6 mm inside diameter, maximum 9 mm outside diameter, and of such a depth as to compensate the spherical defect;

c2) ablation with a customized ablative pattern to eliminate higher than second-order defects, with reference to aberrometric data acquired prior to the 10 operation in the preceding point; and

c3) if the above operations fail to achieve a coefficient of Zernike's polynomial Z_4^0 ranging between 0.1 and 1.0, ablation with a customized ablative pattern to obtain even greater spherical aberration;

d) if the visual defect of the eye is hypermetropia and positive astigmatism or 15 hypermetropia and negative astigmatism, controlling said excimer laser unit (1) to perform the following operations:

d1) cylindrical ablation, with the excimer laser unit (1) set solely to the cylindrical defect, to bring the cylindrical defect close to zero;

d2) ablation of a circular corona of maximum 6 mm inside diameter, 20 maximum 9 mm outside diameter, and of such a depth as to compensate the spherical defect;

d3) ablation with a customized ablative pattern to eliminate higher than second-order defects, with reference to aberrometric data acquired prior to the operation in the preceding point; and

25 d4) if the above operations fail to achieve a coefficient of Zernike's polynomial Z_4^0 ranging between 0.1 and 1.0, ablation with a customized ablative pattern to obtain even greater spherical aberration;

e) if the visual defect of the eye is myopia, controlling said excimer laser unit

(1) to perform the following operations:

- e1) ablation to such a depth as to compensate the spherical defect; and
 - e2) ablation with a customized ablative pattern to induce positive spherical aberration with a coefficient of Zernike's polynomial Z_4^0 ranging between 0.1 and 5 1.0;
 - f) if the visual defect of the eye is myopia and positive astigmatism or myopia and negative astigmatism, controlling said excimer laser unit to perform the following operations:
 - f1) cylindrical ablation, with the excimer laser unit set solely to the 10 cylindrical defect, to bring the cylindrical defect close to zero;
 - f2) ablation to such a depth as to compensate the spherical defect; and
 - f3) ablation with a customized ablative pattern to induce positive spherical aberration with a coefficient of Zernike's polynomial Z_4^0 ranging between 0.1 and 1.0;
 - g) if the visual defect of the eye is emmetropia, controlling said excimer laser 15 unit to perform:
 - g1) operations d2), d3) and d4), if the visual defect improves using a positive lens; and
 - g2) operations e1) and e2), if the visual defect improves using a negative lens;
 - h) if the visual defect of the eye is positive astigmatism or negative 20 astigmatism, controlling said excimer laser unit to perform:
 - h1) operation d1) to achieve emmetropia;
 - h2) operations d2), d3) and d4), if the visual defect improves using a positive lens; and
 - h3) operations e1) and e2), if the visual defect improves using a negative lens.
- 7) A control method as claimed in any one of the foregoing Claims, characterized by also comprising the step of:
- i) controlling said excimer laser unit (1) to form on the cornea a photoablative

pattern which also corrects higher-order aberrations.

8) An excimer laser unit (1) for performing cornea ablation to reduce presbyopia, characterized by comprising:

5 a) first control means (10-60, 80) for controlling said excimer laser unit (1) to form on the cornea a photoablative pattern inducing a fourth-order ocular aberration.

9) An excimer laser unit as claimed in Claim 8, characterized in that said induced fourth-order aberration is a spherical aberration.

10) An excimer laser unit as claimed in Claim 9, characterized in that said induced spherical aberration is a positive spherical aberration.

11) An excimer laser unit as claimed in any one of Claims 8 to 10, characterized in that said first control means (10-60, 80) comprise:

15 a1) aberrometric measuring means (10) for acquiring an aberrometric map of the eye indicating the visual defects of the eye, said visual defects comprising second-order visual defects including hypermetropia, astigmatism and myopia, and higher-order visual defects including spherical aberration;

20 a2) first photoablative pattern generating means (20, 30, 40, 50) which are activated, if the detected spherical aberration is negative, to numerically increase in absolute value the spherical aberration detected by said aberrometric measuring means (10), and so generate a photoablative pattern inducing positive spherical aberration;

a3) second photoablative pattern generating means (20, 30, 40, 60) which are activated, if the detected spherical aberration is positive, to change the sign of and numerically increase in absolute value the spherical aberration detected by said aberrometric measuring means (10), and so generate a photoablative pattern inducing positive spherical aberration;

a4) supply means (80) for supplying the photoablative pattern so generated to said excimer laser unit (1) for implementation on said cornea.

25 12) An excimer laser unit as claimed in any one of Claims 8 to 11,

characterized in that said first control means (10-60, 80) control said excimer laser unit (1) to perform a specific photoablative treatment related to the visual defect of the eye associated with the presbyopia.

13) An excimer laser unit as claimed in Claim 12, characterized in that said
5 first control means (10-60, 80) :

c) if the visual defect of the eye is hypermetropia, control said excimer laser unit (1) to perform the following operations:

c1) ablation of a circular corona of maximum 6 mm inside diameter, maximum 9 mm outside diameter, and of such a depth as to compensate the spherical
10 defect;

c2) ablation with a customized ablative pattern to eliminate higher than second-order defects, with reference to aberrometric data acquired prior to the operation in the preceding point; and

c3) if the above operations fail to achieve a coefficient of Zernike's
15 polynomial Z_4^0 ranging between 0.1 and 1.0, ablation with a customized ablative pattern to obtain even greater spherical aberration;

d) if the visual defect of the eye is hypermetropia and positive astigmatism or hypermetropia and negative astigmatism, control said excimer laser unit (1) to perform the following operations:

20 d1) cylindrical ablation, with the excimer laser unit (1) set solely to the cylindrical defect, to bring the cylindrical defect close to zero;

d2) ablation of a circular corona of maximum 6 mm inside diameter, maximum 9 mm outside diameter, and of such a depth as to compensate the spherical defect;

25 d3) ablation with a customized ablative pattern to eliminate higher than second-order defects, with reference to aberrometric data acquired prior to the operation in the preceding point; and

d4) if the above operations fail to achieve a coefficient of Zernike's

polynomial Z_4^0 ranging between 0.1 and 1.0, ablation with a customized ablative pattern to obtain even greater spherical aberration;

e) if the visual defect of the eye is myopia, control said excimer laser unit (1) to perform the following operations:

5 e1) ablation to such a depth as to compensate the spherical defect; and

e2) ablation with a customized ablative pattern to induce positive spherical aberration with a coefficient of Zernike's polynomial Z_4^0 ranging between 0.1 and 1.0;

f) if the visual defect of the eye is myopia and positive astigmatism or myopia
10 and negative astigmatism, control said excimer laser unit (1) to perform the following operations:

f1) cylindrical ablation, with the excimer laser unit (1) set solely to the cylindrical defect, to bring the cylindrical defect close to zero;

15 f2) ablation to such a depth as to compensate the spherical defect; and
f3) ablation with a customized ablative pattern to induce positive spherical

aberration with a coefficient of Zernike's polynomial Z_4^0 ranging between 0.1 and 1.0;

g) if the visual defect of the eye is emmetropia, control said excimer laser unit (1) to perform:

20 g1) operations d2), d3) and d4), if the visual defect improves using a positive lens; and

g2) operations e1) and e2), if the visual defect improves using a negative lens;

h) if the visual defect of the eye is positive astigmatism or negative astigmatism, control said excimer laser unit (1) to perform:

25 h1) operation d1) to achieve emmetropia;

h2) operations d2), d3) and d4), if the visual defect improves using a positive lens; and

h3) operations e1) and e2), if the visual defect improves using a negative lens.

14) An excimer laser unit as claimed in any one of claims 8 to 10, characterized by also comprising:

i) second control means (10, 20, 70, 80) for controlling said excimer laser unit (1) to form on the cornea a photoablative pattern which also corrects higher-order aberrations.

5 15) A method of reducing presbyopia, characterized by comprising the step of:

- forming on the cornea a photoablative pattern inducing a fourth-order ocular aberration.

10 16) A method as claimed in Claim 15, characterized in that said fourth-order aberration is a spherical aberration.

17) A method as claimed in Claim 16, characterized in that said spherical aberration is a positive spherical aberration.